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TECHNICAL INSPECTION ~~CONFIDENTIAL~~ REPORT

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By Authority of JOINT CHIEFS OF STAFF JCS 1795/36 DATED 15 APRIL 1953
By *John H. Deyette* Date 29 SEP 1953

027293

⑥ OPERATION CROSSROADS
U.S.S. TUNA (SS203)

TEST BAKER [U] ⁸

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Director
Defense Atomic Support Agency
Washington, D. C. 20301

- ⑩ C.L. Gaasterland
- ⑪ 1947,
- ⑫ 87p.
- ⑭ XRD-112

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OPERATION CROSSROADS

DIRECTOR OF SHIP MATERIAL

JOINT TASK FORCE ONE

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TECHNICAL INSPECTION REPORT

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Director
Defense Atomic Support Agency
Washington, D. C. 20301

SUBMITTED:

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Captain, U.S.N.

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USS TUNA (SS203)

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USS TUNA (SS203)

U.S.S. TUNA (SS203)

SHIP CHARACTERISTICS

Building Yard: Mare Island Naval Shipyard.

Commissioned: 6 January 1941.

HULL

Light Hull Construction.

Length Overall: 307 feet 0 inches.

Length (between perpendiculars): 302 feet 3 3/4 inches.

Beam (extreme): 27 feet 3 inches.

Beam (molded): 27 feet 0 inches.

Height (lowest point of keel to top of periscope supports): 47 feet 3 inches.

Drafts (at time of test): Submerged.

Standard Displacement: 1475 tons.

Displacement (at time of test): 2297 tons.

MAIN PROPULSION PLANT

Main Engines: Four Fairbanks-Morse, 9 cylinder,
Type 38D8.

Auxiliary Engine: Fairbanks-Morse, 7 cylinder,
Type 38D5.

Main Motors and Generators: General Electric.

Main Storage Battery: Exide.

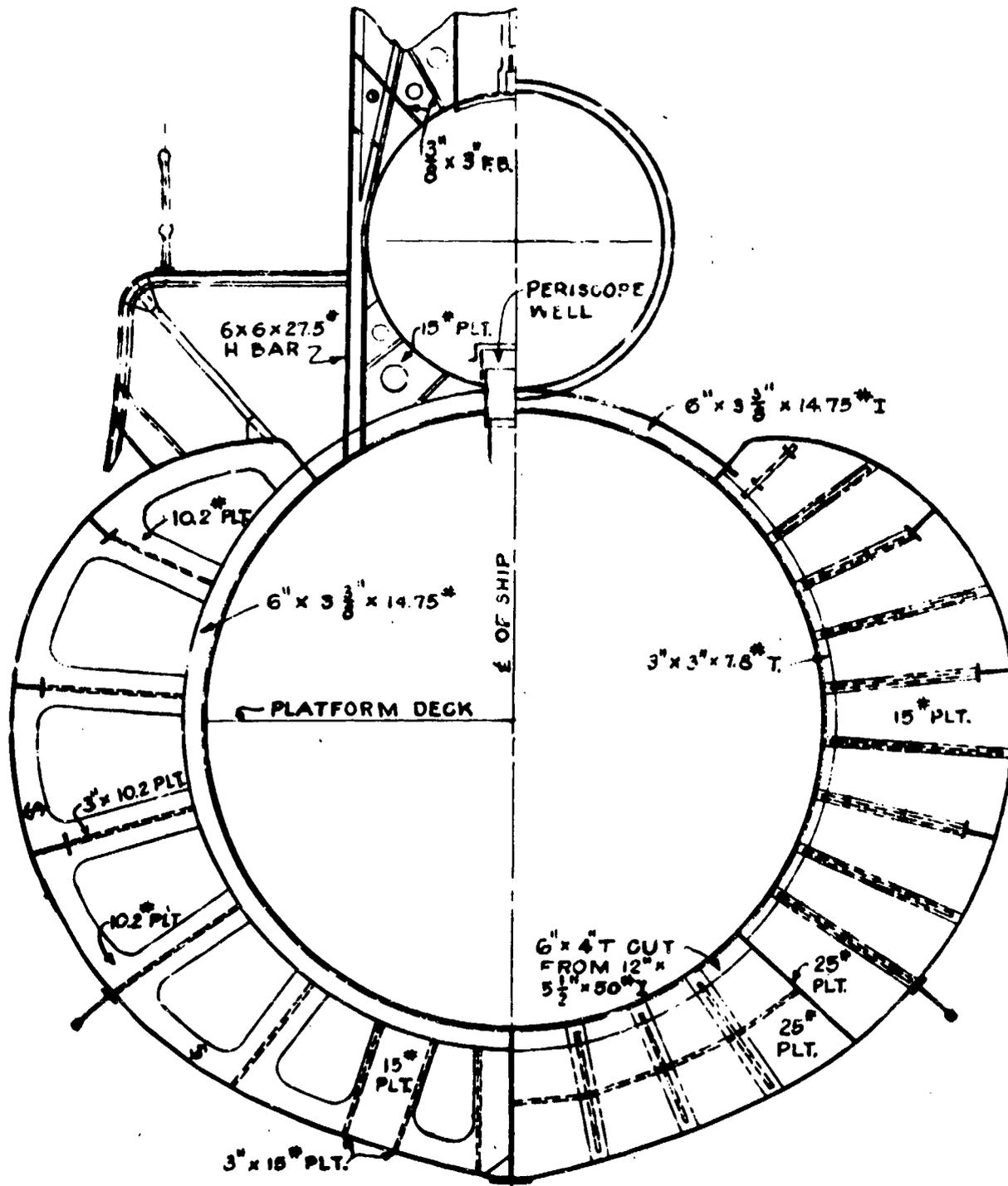
Main Controls: General Electric.

Reduction Gears: Farrel-Birmingham.

Diesel Electric Drive.

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US^S TUNA (SS203)



TYPICAL LIGHTENED FLOOR & SECTION THRU SUPERSTRUCTURE
LOOKING FORD.

WING BULKHEAD 52
LOOKING FORD.

TEST B

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USS TUNA (SS 203)

TECHNICAL INSPECTION REPORT

OVERALL SUMMARY

I. Target Condition After Test.

(a) Drafts after test; list; general areas of flooding, sources.

The TUNA was submerged to eighty feet keel depth for test B at a range of approximately 1600 yards from the center of the burst. When resurfaced she had normal drafts and no list. Number three main engine had flooded due to leaking inboard and outboard exhaust valves which is attributed to age of material rather than to direct effects of the bomb.

(b) Structural damage.

None.

(c) Other damage.

All hull equipment was fully operable.

All machinery was fully operable after draining water out of number three main engine.

All electrical equipment was operable except that mercury had been spilled from master and auxiliary gyro compasses, the master gyro follow up system would not function due to an open circuit in the alarm bell relay coil and there was a full voltage ground in No. 3 main motor caused by salt water leaking from a defective sea valve and cooler.

II. Forces Evidenced and Effects Noted.

(a) Heat.

None evidenced.

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(b) Fires and explosions.

None evidenced.

(c) Shock.

There was no evidence of shock other than a broken glass in the gyro repeater in the forward torpedo room and the spillage of mercury from the master and auxiliary gyro compasses.

(d) Pressure.

The 'Coordinators Report on Air Blast and Water Shock for tests A and B' of 27 September 1946 indicates that the peak water pressures were considerably less than 800 lbs. per square inch. The elastic deformation of the single hull, measured at four stations was not greater than 0.13 inches.

(e) Any effects apparently peculiar to the atom bomb.

Retention of radioactivity by the ship outside the pressure hull were the only noted effects peculiar to the atom bomb.

III. Effect of Damage.

(a) Effect on machinery, electrical and ship control.

None except temporary loss of use of gyro compasses.

(b) Effect on Gunnery and Fire Control.

Automatic feed of own ship's course to the Torpedo Data Computer was inoperable due to failure of master gyro follow up system.

(c) Effect on watertight integrity and stability.

None.

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(d) Effect on personnel and habitability.

None except for the effects of radioactivity.

(e) Total effect on fighting efficiency.

A slight temporary reduction in fighting efficiency would have resulted from the loss of the gyro compass follow up system.

IV. General Summary of Observer's Impressions and Conclusions.

Except for the radiological phenomena experienced, this vessel was beyond the range of effectiveness of the bomb used in test B. For general views of TUNA after test B see photographic section on pages 26 to 33.

V. Preliminary Recommendations.

No comment.

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USS TUNA (SS203)

TECHNICAL INSPECTION REPORT

SECTION I - HULL

GENERAL SUMMARY OF HULL DAMAGE

I. Target Condition After Test.

- (a) Drafts after test; list; general areas of flooding, sources.

No flooding occurred, hence there were no changes in draft or list.

- (b) Structural damage.

None.

- (c) Other damage.

None to hull material.

II. Forces Evidenced and Effects Noted.

- (a) Heat.

No evidence.

- (b) Fires and explosions.

No evidence.

- (c) Shock.

None.

- (d) Pressure.

The 'Coordinator's Report on Air Blast and Water Shock for tests A and B' of 27 September 1946 indicates that the peak water pressures were considerably less than 800 lbs. per square inch. The elastic deformation of one single hull, measured at four stations was not greater than 0.13 inches.

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USS TUNA (SS203)

(e) Effects apparently peculiar to the Atom Bomb.

None.

III. Effects of Damage.

(a) Effect on machinery, electrical and ship control.

None.

(b) Effect on gunnery and fire control.

None.

(c) Effect on watertight integrity and stability.

None.

(d) Effect on personnel and habitability.

Except for the effects of radioactivity it is considered that personnel and habitability would not have been affected by the test.

(e) Total effect on fighting efficiency.

The longitudinal strength, buoyancy, stability, watertight integrity, and seaworthiness of the vessel and the operability of hull equipment were not affected by the test. There is no effect on the fighting efficiency insofar as hull material is concerned.

IV. General Summary of Observer's Impressions and Conclusions.

Except for the radiological phenomena experienced, this vessel was beyond the range of effectiveness of the bomb used in Test B.

V. Preliminary Recommendations.

None.

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USS TUNA (SS203)

DETAILED DESCRIPTION OF HULL DAMAGE

A. General Description of Hull Damage.

No damage.

B. Superstructure.

No damage.

C. Turrets, Guns and Directors.

No damage.

D. Torpedo Mounts, Depth Charge Gear.

No damage.

E. Weather Deck.

No damage.

F. Exterior Hull.

No damage.

G. Interior Compartments (above w.l.).

No damage.

H. Armor Decks and Miscellaneous Armor.

Not applicable.

I. Interior Compartments (below w.l.).

No damage.

J. Underwater Hull.

No damage.

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K. Tanks.

No damage.

L. Flooding.

None.

M. Ventilation.

No damage.

N. Ship Control.

No damage.

O. Fire Control.

No damage.

P. Ammunition Behavior.

No damage.

Q. Ammunition Handling.

No damage.

R. Strength.

No damage.

S. Miscellaneous.

No comment.

T. Coverings.

No damage.

U. Welding and Rivetting.

No damage.

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USS TUNA (SS 203)

TECHNICAL INSPECTION REPORT

SECTION II - MACHINERY

GENERAL SUMMARY OF MACHINERY DAMAGE

I. Target Condition After Test.

(a) Drafts after test; list; general areas of flooding sources.

The TUNA was submerged to eighty feet keel depth for test B. When resurfaced she had normal drafts and no list. Her number three main engine had flooded due to leaking outboard and inboard exhaust valves. This was not caused by the bomb. The engine was drained down and run satisfactorily.

(b) Structural damage.

None observed.

(c) Other damage.

All machinery operable. No damage observed as a result of target test.

II. Forces Evidenced and Effects Noted.

(a) Heat.

None evidenced.

(b) Fires and explosions.

None evidenced.

(c) Shock.

Small shock was evidenced in some loss of mercury from auxiliary gyro compass and very slight loss of mercury from master gyro.

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USS TUNA (SS203)

(d) Pressure.

None evidenced.

(e) Effects apparently peculiar to the atom bomb.

Only effect noted apparently peculiar to the atom bomb was retention of radioactivity by the ship outside the pressure hull.

III. Effects of Damage.

(a) Effect on machinery and ship control.

None except loss of use of auxiliary gyro compass.

(b) Effect on gunnery and fire control.

None.

(c) Effect on watertight integrity and stability.

None.

(d) Effect on personnel and habitability.

None. No personnel casualties would have occurred except possibly from radiological effects. Inside of ship was below radiological tolerance when opened up.

(e) Total effect on fighting efficiency.

None.

IV. General Summary of Observers' Impressions and Conclusions.

It is apparent that a submarine of light hull construction would suffer no structural nor machinery damage from an underwater burst of an Atomic Bomb of like strength at a similar range.

V. Preliminary Recommendations.

No comment.

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USS TUNA (SS203)

DETAILED DESCRIPTION OF MACHINERY DAMAGE

A. General Description of Machinery Damage.

(a) Overall condition.

Undamaged. All machinery was tested and was operable as before test. Number three main engine was flooded due to leaking inboard and outboard exhaust valves. This was due to material conditions of exhaust valves and not the result of the test.

(b) Areas of major damage.

None

(c) Primary causes of damage in each area of major damage.

None. No damage to machinery.

(d) Effect of Target Test on overall operation of machinery plant.

No effect. Machinery plant operable as before test. Number three main engine was drained and was run satisfactorily.

B. Boilers.

Not applicable.

C. Blowers.

Not applicable,

D. Fuel Oil Equipment.

No damage.

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E. Boiler Feedwater Equipment.

Not applicable.

F. Main Propulsion Machinery.

No damage.

G. Reduction Gears.

No damage.

H. Shafting and Bearings.

No damage.

I. Lubrication System.

No damage.

J. Condensers and Air Ejectors.

Not applicable.

K. Pumps.

No damage.

L. Aux. Generators (Turbines and Gears).

Discussed under Item F.

M Propellers.

No damage.

N. Distilling Plant.

No damage.

O. Refrigeration Plant.

No damage.

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USS TUNA (SS203)

P. Winches, Windlasses, and Capstans.

No damage.

Q. Steering Engine.

No damage.

R. Elevators, Ammunition hoists, etc.

Not applicable.

S. Ventilation (Machinery).

No damage.

T. Compressed Air Plant.

No damage.

U. Diesels (Generators and Boats).

Not applicable. See Item F.

V. Piping Systems.

No damage.

W. Hydraulic System.

No damage.

X. Navigational Instruments.

No damage.

Y. Periscopes,

No damage.

Z. Radar and Sonar.

No damage.

AA. Miscellaneous.

None.

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USS TUNA (SS203)

TECHNICAL INSPECTION REPORT

SECTION III - ELECTRICAL

GENERAL SUMMARY OF ELECTRICAL DAMAGE

I. Target Condition After Test.

(a) Drafts after test; list; general areas of flooding, sources.

Not observed.

(b) Structural damage.

Not observed.

(c) Damage.

Mercury was spilled from both the master and auxiliary gyro compasses. The follow up system of the master gyro compass did not operate due to an open circuit in the alarm bell sensitive relay coil. Number three propulsion motor had a ground due to a leaky sea valve and cooler.

II. Forces Evidenced and Effects Noted.

(a) Heat.

No evidence.

(b) Fires and explosions.

None.

(c) Shock.

The spillage of mercury from the master gyro and the auxiliary gyro was probably caused by shock. There was no other evidence of shock damage.

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USS TUNA (SS 203)

(d) Pressure.

There was no evidence of pressure damage.

(e) Any effects apparently peculiar to the atom bomb.

None other than radioactivity.

III. Effects of Damage.

(a) Effect on propulsion and ship control.

Temporary reduction in propulsion due to ground in number three propulsion motor.

(b) Effect on gunnery and fire control.

The automatic feed of Own Ship's Course to the torpedo data computer did not operate because of the master gyro follow up system failure.

(c) Effect on watertight integrity and stability.

Not observed.

(d) Effect on personnel and habitability.

None except for possible radiological effects.

(e) Effect on fighting efficiency.

A slight temporary effect on fighting efficiency would have resulted from failure of the gyro follow up system.

IV. General Summary of Observers' Impressions and Conclusions.

From the electrical standpoint a submarine submerged at the distance of the TUNA from an atom bomb explosion such as that of Test B would suffer only slight damage of a minor nature.

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V. Preliminary Recommendations.

Design the sensitive relay coil for the master gyro compass follow up system to withstand increased voltage and current. Consideration should be given to revising the follow up circuits so that failure of the sensitive relay coil will not de-energize the gyro follow up system.

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USS TUNA(SS203)

DETAILED DESCRIPTION OF ELECTRICAL DAMAGE

A. General Description of Electrical Damage.

(a) Overall condition.

The overall condition of the electrical equipment was only slightly affected by the bomb blast. A number of moisture grounds were present due to the long submergence of the ship.

(b) Areas of major damage.

None.

(c) Primary causes of damage in each area of major damage.

None.

(d) Effect on target test on overall operation of electric plant.

1. Electrical propulsion:

Operable except for No. 3 propulsion motor, which was temporarily inoperable because of a ground.

2. Main storage batteries:

Operable.

3. Auxiliary power:

Operable.

4. Communications:

Operable.

5. Fire control circuits:

The automatic feed of Own Ship's Course to the torpedo data computer was inoperable due to failure of the master gyro compass follow up system.

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6. Lighting.

Operable.

7. Ventilation.

Operable.

(e) Types of equipment most affected.

Master and auxiliary gyro compasses.

B. Electric propulsion rotating equipment.

There was no damage directly or indirectly attributable to the atom bomb. However, No. 3 propulsion motor developed a ground caused by a leaky sea valve and motor cooler. Commanding Officer's Report No. 11 states that this ship has not been overhauled in two and one half years. The poor material condition of the sea valve and cooler is believed to have been the major cause for this failure. The other three propulsion motors were not affected by similar derangements. Repairs to No. 3 propulsion motor were effected by the ship's crew and the motor was operated satisfactorily.

C. Electric Propulsion Control Equipment.

No damage.

D. Generators - Ship's Service.

Not applicable.

E. Generators - Emergency.

Not applicable.

F. Switchboards, Distribution and Transfer Panels.

No damage.

G. Wiring, Wiring Equipment and Wireways.

No damage.

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U SS TUNA(SS203)

H. Transformers.

No damage.

I. Submarine Propelling Batteries.

No damage. Batteries were fully charged and on open circuit during the test. Analysis of electrolyte samples after the test by Pearl Harbor Naval Shipyard revealed no significant change attributable to the atom bomb.

J. Portable Batteries.

No damage.

K. Motors, Motor - generator Sets and Motor Controllers.

No damage.

L. Lighting Equipment.

No damage.

M. Searchlights.

No damage.

N. Degaussing Equipment.

Not applicable.

O. Gyro Compass Equipment.

The master gyro compass spilled a small amount of mercury but was not otherwise damaged. This is an Arma mark VII, Mod 2A compass. After some mercury was added this compass was placed in operation but the follow up system did not function. The trouble was found to be due to an open circuit in the coil of the sensitive relay which actuates a gyro alarm circuit. The relay is Arma part No. 50377-2, with nameplate data: Ward Leonard, 8.07 volts, D-C, Catalogue No. 251-40. Visual inspection revealed no evidence of shock damage.

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It is believed that the relay coil failed due to an over-voltage or overcurrent in the follow up circuits, possibly caused by moisture grounds. When the relay was by-passed, the follow-up system operated but without the gyro alarm functioning. A similiar failure occurred on two other target submarines after Test B.

Recommendations:

It is understood that gyro compasses of recent design are less susceptible to mercury spillage under shock. The sensitive relay coil should be designed to withstand a higher value of voltage and current. Consideration should be given to revising the follow-up circuits so that failure to the sensitive relay coil will not de-energize the gyro follow-up system.

(b) Auxiliary.

The auxiliary gyro compass spilled about two tablespoons of mercury but was not otherwise damaged. It was placed in operation after the addition of mercury. This type of Arma compass is susceptible to mercury spillage under shock as similiar failures have occurred on other target submarines in Tests A and B. However, it is understood that this compass is now obsolete.

P. Sound Powered Telephones.

No damage.

Q. Ship's Service Telephones.

Not applicable.

R. Announcing Systems

No damage.

S. Telegraphs.

No damage.

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T. Indicating Systems.

No damage.

U. I.C. and A.C.O. Switchboards.

No damage.

V. F.C. Switchboards.

No damage.

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SECTION IV

PHOTOGRAPHS

TEST BAKER

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USS TUNA(SS203)



ABCR-227-290-52. General view from ahead.

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ABCR-227-290-53. General view from starboard bow.

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USS TUNA (SS203)

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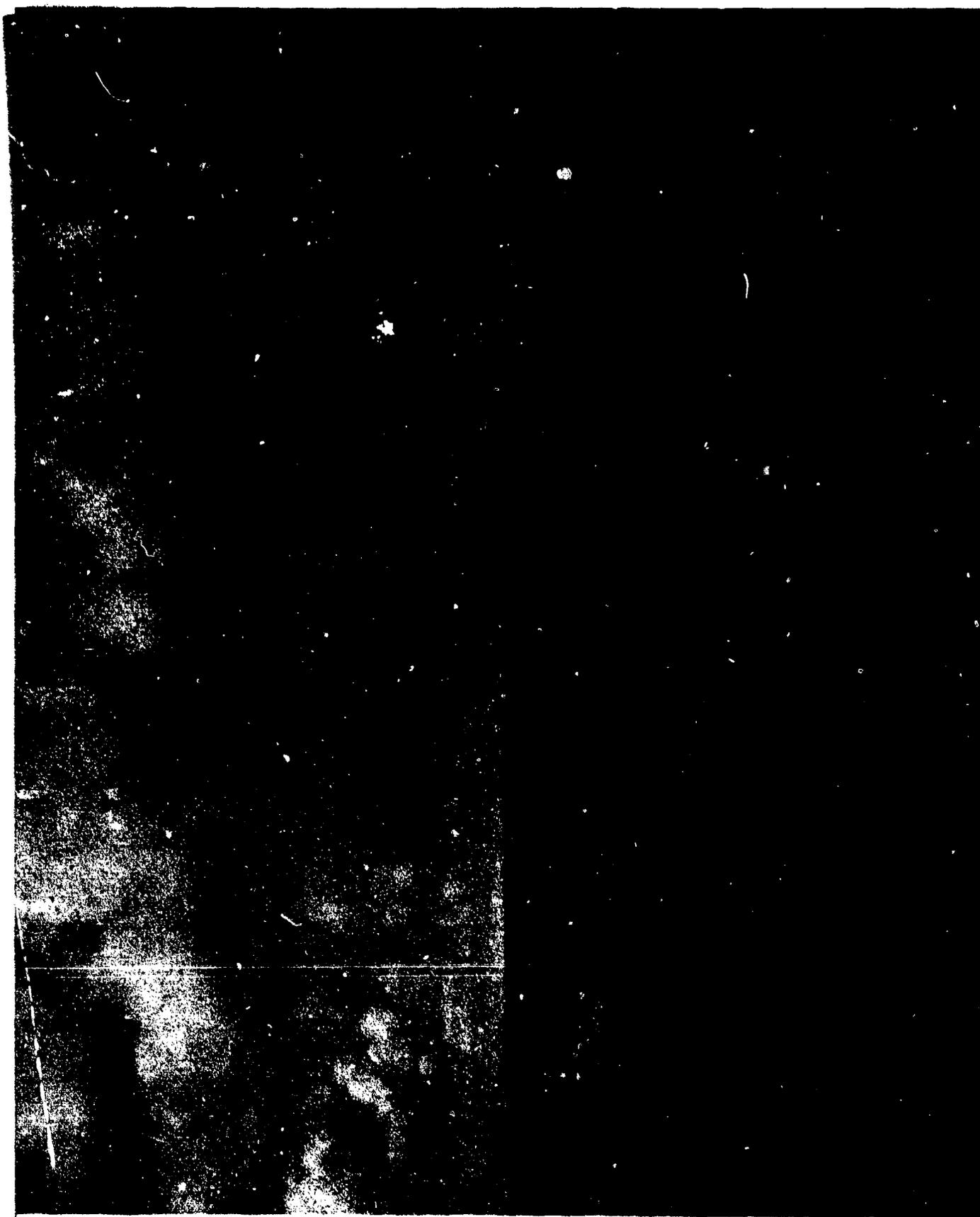
ABCR-227-290-54. General view from starboard beam.

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ABCR-227-290-55. General view from starboard quarter.

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ABCR-227-290-48. General view from astern.

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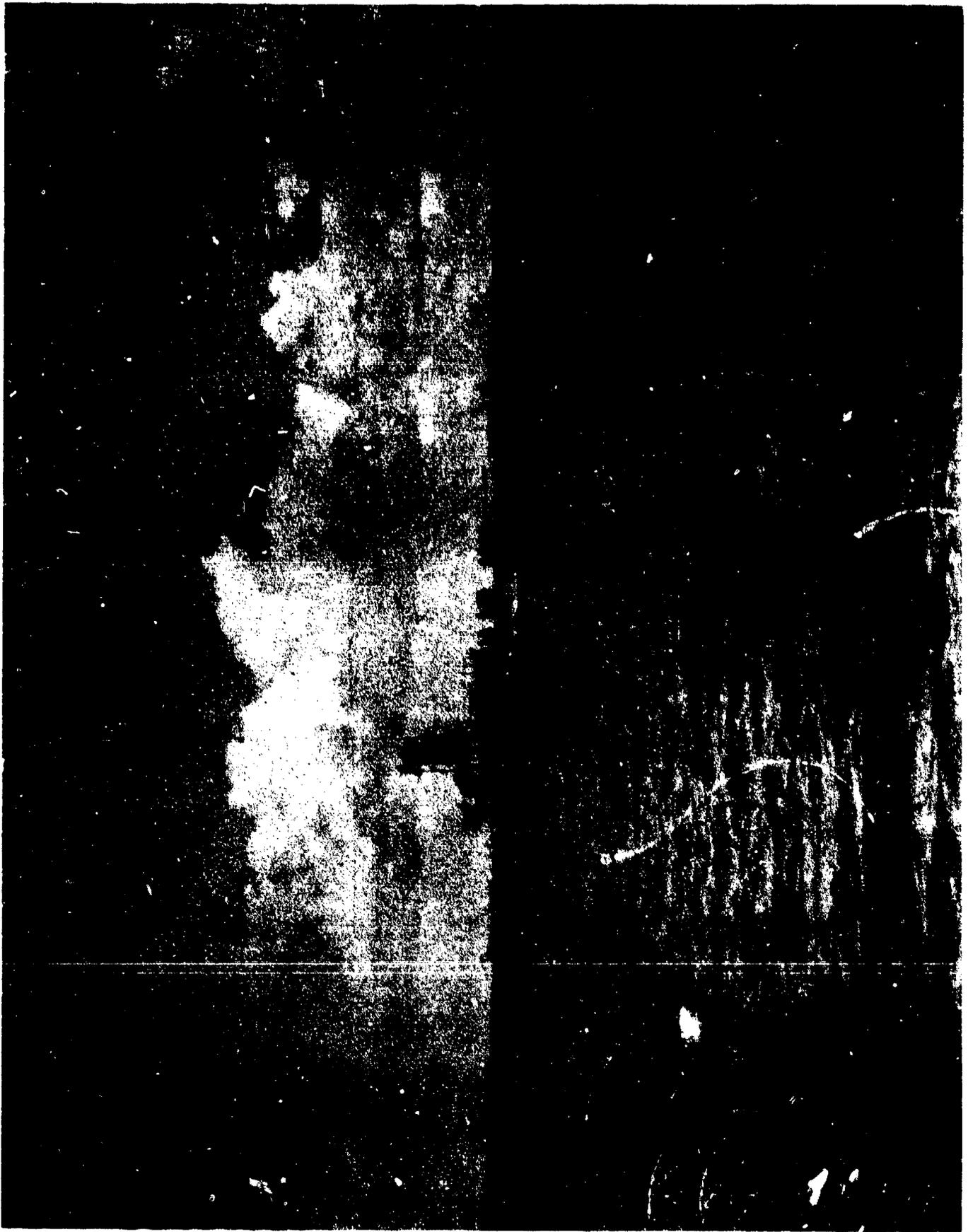
ABCR-227-290-49. General view from port quarter.

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ABCR-227-290-50. General view from port beam.

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ABCR-227-290-51. General view from port bow.

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USS TUNA (SS203)

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APPENDIX

COMMANDING OFFICER'S REPORT

TEST BAKER

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USS TUNA (SS203)

PART A. GENERAL SUMMARY

I. Target condition after test.

(a) Drafts after test; list; general areas of flooding; sources.

1. Drafts same.

2. No list.

3. No flooding.

(b) Structural damage; superstructure, pressure hull, ballast tanks, compartments.

1. None.

(b) Operability; electrical, ship control, machinery, fire control, gunnery, electronics.

1. No change except the following:

a. Number three main engine was flooded due to a leaky outboard exhaust valve which has been in bad shape for quite some time.

b. Number three main motor had a full voltage ground. This was caused by a leaky sea valve and main motor cooler. This vessel has not been overhauled for over two-and-one-half years; therefore such conditions in material can be expected.

c. Mercury was spilled from the Auxiliary Gyro Compass (this occurred during test ABLEF also). A very slight amount of mercury was spilled from the Master Gyro.

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(d) Heat: fires; estimated personnel casualties.

1. No fires.

II. Forces evidenced and effects noted.

(a) Heat: apparent direction (if any); extent longitudinally, transversely, penetration, significant behavior of structure equipment.

1. None evident.

(b) Fires and Explosions: situation; nature of combustible or explosive; normal stowage; cause of ignition;

1. None.

(c) Shock: apparent direction (if any); areas affected; critical scantlings; nature of joint failures (general); effect on machinery and equipment; significant behavior of structure and equipment.

1. It is believed that this vessel received some shock, which caused the mercury to spill from the Auxiliary and Master Gyros.

(d) Any effects apparently peculiar to the Atom Bomb.

1. None.

III. Results of Test on Target.

(a) Effect on propulsion and ship control.

1. None.

(b) Effect on gunnery and fire control.

1. None.

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(c) Effect on water-tight integrity and stability.

1. None.

(d) Effect on personnel and habitability.

1. No radio-activity has been detected inside the pressure hull.

(e) Total effect on fighting efficiency.

1. None.

IV. General Summary.

No damage was suffered by this vessel in test BAKER. Whether or not radio-activity would have caused personnel casualties inside the pressure hull this commanding officer cannot say. The only radio-activity found after reboarding, was topside,

V. Recommendations of the Inspecting Group.

None.

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USS TUNA (SS203)



Defense Special Weapons Agency
6801 Telegraph Road
Alexandria, Virginia 22310-3398

TRC

18 April 1997

MEMORANDUM FOR DEFENSE TECHNICAL INFORMATION CENTER
ATTENTION: OMI/Mr. William Bush (Security)

SUBJECT: Declassification of Reports

The Defense Special Weapons Agency has declassified the following reports:

| | |
|--------------------------|------------------------|
| ✓AD-366588 4 | XRD-203-Section 12✓ |
| AD-366589 L | XRD-200-Section 9 |
| AD-366590 L | XRD-204-Section 13 |
| AD-366591 L | XRD-183 |
| ✓AD-366586 X | XRD-201-Section 10✓ |
| ✓AD-367487 X | XRD-131-Volume 2✓ |
| ✓AD-367516 4 | XRD- 3 143✓ |
| ✓AD-367493 X | XRD-142✓ |
| AD-801410L✓ | XRD-138 |
| AD-376831L✓ | XRD-83 |
| AD-366759 L | XRD-80 |
| ✓AD-376830L X | XRD-79✓ |
| ✓AD-376828L X | XRD-76✓ |
| ✓AD-367464 X | XRD-106✓ |
| AD-801404L✓ | XRD-105-Volume 1 |
| ✓AD-367459 X | XRD-100✓ |

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18 April 1997

Subject: Declassification of Reports

| | |
|--------------|---------------------------------|
| ✓AD-367491 ✕ | XRD-134-Volume 2 ✓ |
| ✓AD-367479 ✕ | XRD-123 ✓ |
| ✓AD-367478 ✕ | XRD-122 ✓ |
| ✓AD-367481 ✕ | XRD-125 ✓ |
| AD-367500 ✓ | XRD-159-Volume 2 <i>revised</i> |
| ✓AD-367499 ✕ | XRD-160-Volume 3 ✓ |
| ✓AD-367498 ✕ | XRD-161-Volume 4 ✓ |
| AD-367512 ✓ | XRD-147 |
| AD-367511 ✓ | XRD-148 |
| ✓AD-367465 ✕ | XRD-107 ✓ |
| AD-366733 ✓ | XRD-43 |
| ✓AD-367477 ✕ | XRD-121 ✓ |
| ✓AD-367476 ✕ | XRD-120 ✓ |
| ✓AD-367467 ✕ | XRD-109-Volume 1 ✓ |
| ✓AD-367475 ✕ | XRD-119 ✓ |
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| AD-367470 ✕ | XRD-112 ✓ |
| AD-367469 ✕ | XRD-111 ✓ |

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18 April 1997

Subject: Declassification of Reports

AD-801406L ✓ XRD-114.

In addition, all of the cited reports are now **approved for public release; distribution statement "A" now applies.**

Arduith Jarrett

ARDITH JARRETT
Chief, Technical Resource Center